

Box 8

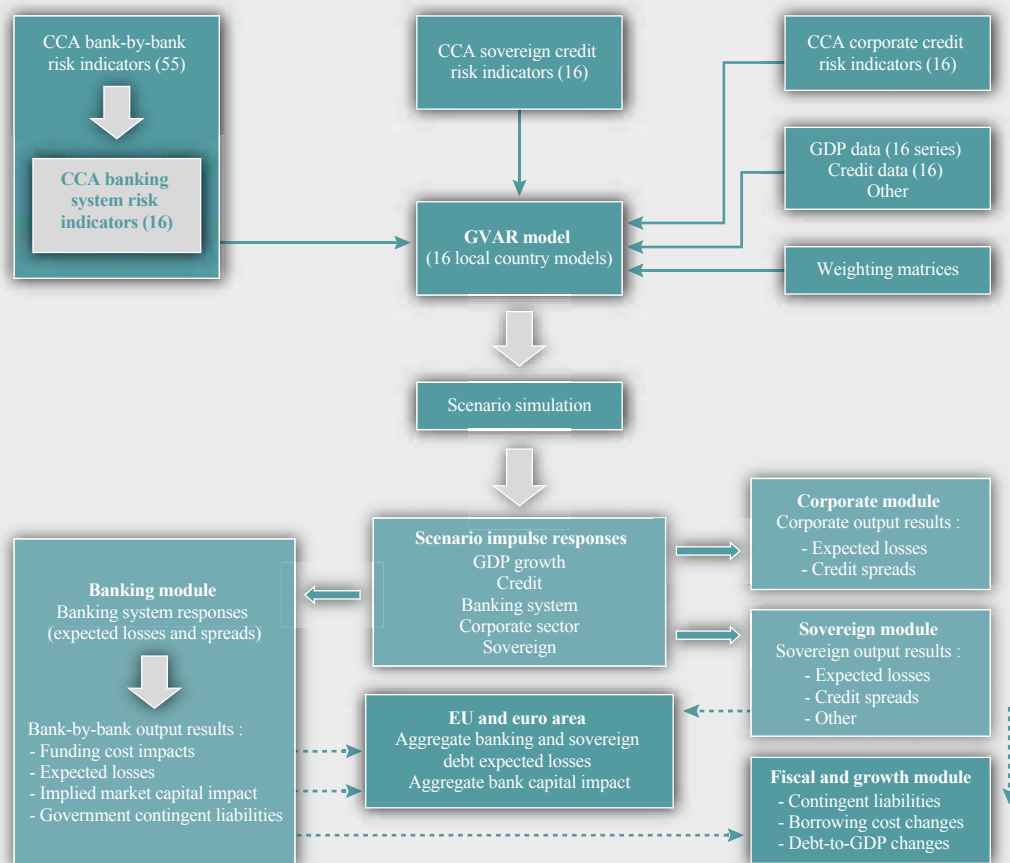
MODELLING THE JOINT DYNAMICS OF BANKING, SOVEREIGN, MACRO AND CORPORATE RISK

While the global financial crisis has seen many phases, a main feature has been the interplay of risks across various economic and financial sectors, even culminating in outright risk transfer in some cases. Prominent examples have included the spillover of fragilities from the financial sector to the broader economy and from the banking sector to the sovereign sector. In monitoring the propensity for such phenomena to occur and in evaluating their impact, direct (i.e. accounting) linkages tend to understate risks. Earlier and more robust signals of the possibility for cross-sectoral linkages to cause systemic stress can be obtained via contingent claims analysis (CCA), which augments cross-sectoral linkages on the basis of the main tenets of financial option pricing.¹

This box applies such a methodology to the joint dynamics among three sectors that are key in crisis propagation (the banking, sovereign and corporate sectors), along with real economic

¹ Contingent claims analysis is a risk-adjusted balance sheet approach for banks, corporates and sovereigns, where the value of liabilities is derived from assets and assets are uncertain. The value of assets equals the value of equity plus risky debt, where risky debt is the default-free value of debt minus the expected loss due to default. CCA balance sheets are very useful as they incorporate forward-looking credit risk, which is non-linear, and can analyse risk transmission between banks, corporates, sovereigns and the macroeconomy. CCA balance sheets are calibrated using the value and volatility of equity plus accounting information on debt in an option-theoretic framework. For a summary of the main research in this field, see D. Gray and S. Malone, *Macrofinancial Risk Analysis*, John Wiley & Sons, 2008.

Chart A CCA-GVAR modelling framework



Source: ECB.

activity and credit growth in a Global Vector Autoregressive (GVAR) model.² The model, which allows for explicit cross-sectoral (and cross-country) interactions, is set up for 13 EU countries as well as Norway, Switzerland and the United States and has been estimated based on a sample period from January 2002 to December 2012.³ The model is used to assess the same scenarios that are analysed by means of a solvency analysis earlier in this section of the FSR. The advantage of the CCA-GVAR approach is that it allows for an endogenous reaction of all relevant sectors in the economy. The analysis relies on three forward-looking risk indicators derived from CCA: (i) fair-value spreads⁴, which pool multiple sources of default risk, including the market price of risk; (ii) loss given default; and (iii) the expected default frequency. The main difference between the CCA-GVAR model approach and the forward-looking solvency analysis, as presented earlier in this section, is that the CCA-GVAR framework operates with

2 See Table 3.2 for the GDP shocks that were used as input to the CCA-GVAR model (note that monthly GDP data are obtained via interpolation). For a detailed description of the methodology, see D. Gray, M. Groß, J. Paredes and M. Sydow, "Modeling Banking, Sovereign and Macro Risk in a CCA Global VAR", *IMF Working Paper*, forthcoming.

3 The model sample includes nine euro area countries, namely Austria, Belgium, France, Germany, Ireland, Italy, the Netherlands, Portugal and Spain. Other euro area countries have been excluded from the sample due to data limitations regarding available historical time series.

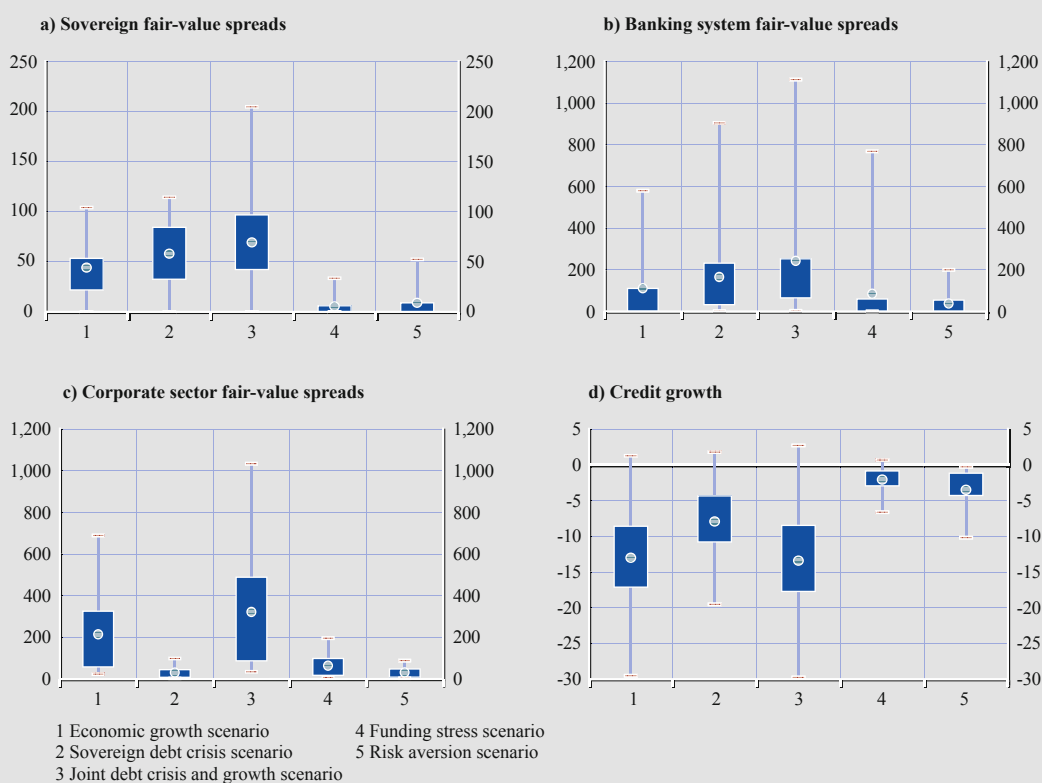
4 Historically, fair-value spreads exhibit differences in terms of magnitude compared with CDS spreads, e.g. for some banks in the sample, fair-value spreads can be a multiple of the corresponding CDS spread.

broad balance sheet items (i.e. assets, liabilities and equity capital) aggregated at the country level. In that sense, it has a “macro” perspective to the balance sheet, instead of the “micro” view that the solvency analysis takes, which involves specific models for various bank balance sheet components (such as interest income, interest expense, loan losses, mark-to-market valuation losses, etc.) that are then applied at a bank-by-bank level. Chart A presents a schematic overview of the overall modelling framework.

The results suggest that a joint sovereign debt crisis and growth shock scenario is the most potent for inducing stress for sovereigns, banks and the corporate sector – with other shocks being more sector-specific (see Chart B). For *sovereigns*, the average maximum cumulative response over two years is significant, approaching 70 basis points in terms of changes in fair-value spreads. Regarding other scenarios, the sovereign debt crisis, growth and risk aversion shock scenarios carry the largest impacts, with a fair degree of positive skew towards higher impacts in selected countries. For the *banking sector*, the cross-country distributions are even more strongly skewed, with average fair-value spread responses under all five scenarios being close to the upper quartiles, meaning that there are a few banking systems that are particularly severely hit (with fair-value spread responses surpassing 1,000 basis points for some banking systems).

Chart B Distribution of country-specific responses under different adverse shock scenarios

(2013 – 2014; cumulative; basis points; maximum, minimum, interquartile distribution and average)



Sources: ECB, Moody's Analytics and ECB calculations.

Notes: Responses are the maximum cumulative deviation from end-sample (December 2012) spread levels over a two-year forward horizon. For panels a)-c), an increase in spreads reflects a higher level of risk perception. The following countries are covered in this analysis: Austria, Belgium, Denmark, France, Germany, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States.

It is striking that credit spread responses for banks are more pronounced than the sovereign risk measures, on average by a factor of approximately three across scenarios and countries. Again, the strongest average spread responses can be found under the joint sovereign debt crisis and growth shock scenario, with the average maximum cumulative response for the banking system fair-value spreads approaching 250 basis points. For the *corporate sector*, the responses are somewhat more pronounced than those of the banking sector, with average fair-value spread responses under the joint sovereign debt crisis and contagion scenario approaching 320 basis points. Moreover, it is worth highlighting that across countries for all remaining scenarios the corporate sector is mainly affected by the economic growth scenario. With regard to *credit growth*, the joint sovereign debt crisis and economic growth scenario leads on average to a 13% reduction in credit, with less pronounced effects under the sovereign debt crisis and risk aversion scenarios. The impact conditional on the funding stress scenario appears to be small indeed.

Under all scenarios, euro area countries are more strongly affected by the adverse shocks than the other countries that are part of the sample.

The finding that the joint sovereign debt crisis and economic growth scenario has the most adverse implications for the banking sector is fairly consistent with the solvency analysis in this section of the FSR based on more traditional stress-testing tools, where this scenario is ranked second in terms of severity.⁵ In terms of policy implications, this underscores a key role for both economic growth (and stabilisation) as well as measures to limit the contagious forces that are central to the crisis.

⁵ In the CCA-GVAR analysis, the impact of the risk aversion scenario is smaller than the one under the joint sovereign debt crisis and economic growth scenario, the reason being that only a partial set of features that characterise the scenario, specifically the GDP growth assumptions (see Table 3.2 for an overview of GDP growth impacts under all scenarios), are used to feed the CCA-GVAR model. Specifically, the risk aversion scenario envisages further sources of risk that are not reflected in GDP responses and, therefore, not reflected in the results from the CCA-GVAR model output, in particular the impact on corporate bond holdings from the initial corporate bond yield shock.